I. C. 6701

April, 1933

Department of Commerce

UNITED STATES BUREAU OF MINES
Scott Turner, Director

INFORMATION CIRCULAR

SAVING LIFE BY BARRICADING IN MINES AND TUNNELS AT TIMES OF DISASTER

RECEIVED
MAY 13 19
O. S. U. LIBRARY

BY

D. Harrington and M. W. von Bernewitz

I.C. 6701
April, 1933.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

SAVING LIFE BY BARRICADING IN MINES AND TUNNELS AT TIMES OF DISASTER[1]

By D. Harrington[2] and M. W. von Bernewitz[3]

The erection of barricades by men who are shut off from escape in mines at time of fire or after an explosion has been consistently advocated by the United States Bureau of Mines. Largely through the publicity given by the bureau to this excellent type of emergency safety endeavor, several hundred lives have been saved during the past 20 years. One of the earliest instances of barricading in the United States of which there is fairly complete record was in connection with the Cherry mine fire in Illinois in 1909; in this fire 259 lives were lost, but 20 men were saved by two barricades and were brought safely to the surface after seven days. In another coal-mine fire, followed later on by an explosion, at Delagua, Colo., in 1910, 79 lives were lost, but 18 men saved themselves by erecting canvas brattices or barricades; the miners in one barricade were removed safely after five hours and those in another after 21 hours. In 1911, after an explosion in a coal mine at Briceville, Tenn., in which 84 lives were lost, five persons were brought out alive after 58 hours behind a barricade. Twenty hours after an explosion in which 73 were killed at McCurtain, Okla., in 1912, 13 men were taken out alive and one dead from behind a barricade or partition constructed of canvas. In 1914, after an explosion at Eccles, W. Va., in which 181 were killed, 35 men barricaded themselves in one place and after four hours were brought to the surface alive; this barricade was also of canvas. In 1915, 112 men were killed in an explosion at Layland, W. Va., but two groups of men, 47 in all, were able to barricade themselves; after four days 46 men were rescued alive, but one man was dead. In 1915, an explosion at Boomer, W. Va., killed 23, but 27 others barricaded themselves in one place and after seven hours came out alive. All of the foregoing instances of barricading were in coal mines. In 1917 there were three cases of barricading in a Montana metal-mine fire (the North Butte) during which 163 lives were lost. One of the barricades, sheltering 19 men, failed because the region barricaded was in porous broken ground through which the poisonous gases seeped and killed the entire group. From another of the barricades, engineered by an assistant foreman, 8 men were taken out, 6 unconscious and 2 dead, 50 hours after the fire started. The 6 unconscious men lived,

---

[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6701."

[2] Chief engineer, Safety Division, U. S. Bureau of Mines, Washington, D. C.

[3] Safety Division, U. S. Bureau of Mines, Washington, D. C.

725547

but the assistant foreman who directed the men was one of the 2 who had died. In the third case of barricading in this metal-mine fire, 29 men, also led by an assistant foreman, kept themselves closed in for about 36 hours and then broke the barricade or bulkhead, 25 going in one direction to safety, and 4, including the assistant foreman, going in another direction to death from poisonous gases. There have been a number of other cases of barricading, some successful and others a failure. Probably the worst failure was that in the Argonaut (gold) mine fire in California in 1922; all of a group of 46 miners behind a barricade were found dead when reached after 21 days.

During the fiscal year ending June 30, 1930, the safety division of the United States Bureau of Mines came into touch with five instances of barricading. Five groups of miners protected themselves by barricading after explosions in three mines, and at least 47 lives were saved in this manner. In addition to these cases after explosions, in one mine fire where a number of lives were threatened by gases, cool-headed work by some of the mine officials in engineering barricades probably saved 89 lives; in one section 22 persons barricaded themselves, in another place 27 men remained in a section of an underground tunnel between two doors and kept the gases out by filling in the cracks around the doors, and in still another part of the mine 40 others opened one door to allow the poisonous gases to go past the place where they closed themselves off by shutting another door and making it air-tight; after the fire was fought and finally extinguished, the barricaded persons were released, some of them suffering considerably, though none fatally, from the gases.

At the disaster of November 5, 1930, at Millfield, Ohio, in which 82 persons were killed out of a total of about 220 who were in the mine, one of the encouraging features was the finding of 19 men alive (about 10 hours after the explosion) behind a barricade. These men were not within the zone of flame or violence, and while not harmed by the explosion, were being hemmed in by smoke and poisonous gases immediately after the explosion. They retreated toward the end of one of the underground tunnels and erected a partition, or barricade, across the tunnel or entry, shutting out the gases of the explosion. The barricade was constructed of a type of burlap termed "brattice cloth" in coal mining, supplemented by jumpers, shirts, and other articles of the men's clothing, to close any holes in the partition through which the poisonous gases might seep or flow. When these 19 men were found by rescuers, about 10 hours after the explosion, all but two or three of them were unconscious, or semiconscious, but all revived and lived, some of them after having been given artificial respiration, with administration of oxygen and other treatment by first-aid men and doctors at the mine and later at the hospital. In another part of the mine, seven others had attempted to barricade themselves and had actually erected a partition. The gases, however, had entered the place, possibly before completion of the partition, and when the barricade was torn down about 13 hours after the explosion the men were dead and apparently had been dead for several hours.

SUMMARY OF AVAILABLE INSTANCES OF BARRICADING IN MINES AND TUNNELS OF THE UNITED STATES, 1909-1933

No.	Name of mine	State	Mineral mined	Date	Kind of disaster	Men killed	Barricades built by miners	Type of barricade	Length of confinement	Value of barricades	
										Lives saved by them	Lives lost in them
1	Cherry	Illinois	Coal	Nov. 13, 1909	Fire	259	2	Rock, powder cans, mud	7 days	20	- -
2	London	Tennessee	Copper	Nov. 29, 1909	do	- -	1	Boxes, lumber, dirt, clothes	30 hours	8	- -
3	Delagua	Colorado	Coal	Nov. 8, 1910	Explosion and fire	79	2	Canvas	5 days and 21 hours	18	- -
4	Cross Mountain (Briceville)	Tennessee	do	Dec. 9, 1911	Explosion	84	1	Rock and stable hay	58 hours	5	- -
5	San Bois 2 (McCurtain)	Oklahoma	do	Mar. 20, 1912	do	73	1	Canvas and wood door	20 hours	13	1
6	Eccles 6	West Virginia	do	Apr. 28, 1914	do	181	1	Canvas	4 hours	35	- -
7	Layland 3	do	do	Mar. 2, 1915	do	112	2	Board	4 days	46	1
8	Boomer 2	do	do	Nov. 30, 1915	do	23	1	Rock	7 hours	27	- -
9	Sesser 1	Illinois	do	Mar. 15, 1916	Fire	- -	1	Board and rock	2 hours	93	- -
10	Oliphant-Johnson	Indiana	do	Dec. 19, 1916	Explosion	2	2	Board	2 3/4 hours	28	- -
11	Pittsburgh-Idaho	Idaho	Lead and silver	Jan. 3, 1917	Fire	1	1	Rock, boards, clothes	12 hours	8	- -
12	North Butte	Montana	Copper	June 8, 1917	do	163	3	Board, fine dirt, clothes	36 hours	25	[a] 4
									50 hours	6	2
									- -	- -	19
13	West Kentucky 7	Kentucky	Coal	Aug. 4, 1917	Explosion	62	2	Canvas brattice	3 1/2 hours	43	- -
14	Villa	West Virginia	do	May 20, 1918	Fire	13	[b] 1	Rock and coal	- -	- -	[g] 9
15	Amsterdam 2	Ohio	do	Oct. 29, 1919	do	20	[b] 1	do	- -	- -	18
16	Kathleen	Illinois	do	Feb. 23, 1921	do	7	[c] 1	Board	19 days	- -	7
17	Argonaut	California	Gold	Aug. 27, 1922	do	47	[d] 2	do	21 days	- -	46
18	Dolomite 3	Alabama	Coal	Nov. 22, 1922	Explosion	90	2	Rock and fine dirt	4 to 5 hours	50	- -
19	Frontier 1	Wyoming	do	Aug. 14, 1923	do	99	1	do	6 hours	22	- -
20	McClintock	Illinois	do	Jan. 25, 1924	do	33	5	Board and canvas	do	47	- -
21	Cardinal	Colorado	Lead, gold, silver, copper	Dec. 5, 1925	Fire	- -	1	Timber, board, mud, clothes	16 hours	20	[e] 1
22	Jamison 8	West Virginia	Coal	Jan. 14, 1926	Explosion	19	1	Stable feed room	18 hours	20	[f] 2
23	Eccles 5	do	do	Mar. 8, 1926	do	19	1	Canvas, props, dirt	23 hours	10	- -
24	Industrial 18	Illinois	do	Jan. 9, 1928	do	21	1	Canvas (uncompleted)	Several hours	3	- -
25	East 5	West Virginia	do	Dec. 27, 1929	do	2	2	Canvas	3 hours	12	- -
26	Standard 1 and 3	Utah	do	Feb. 6, 1930	do	[g] 20	1	Boards, props, canvas	24 hours	5	- -
27	Wolf Run	Ohio	do	Mar. 10, 1930	Fire	2	3	Gob and canvas	Several hours	[h] 89	- -
28	Carbonado	Washington	do	Apr. 12, 1930	Explosion	17	2	Canvas	do	30	- -
29	Sunday Creek 6	Ohio	do	Nov. 5, 1930	do	82	2	Brattice cloth, clothes	10 hours	19	[j] 7
30	Little Betty	Indiana	do	Jan. 28, 1931	do	28	1	Canvas	Several hours	[k] 7	- -
31	Chicago sewer	Illinois	Rock	Apr. 13, 1931	Fire	11	- -	Air lock	do	[i] 16	- -
	Total					1,569	48			727	117

a - Of these 4 got lost after leaving the barricade and were gassed, 2 died from exhaustion behind the barricade, and 19 overlooked an open manway through which gases entered the bulkheaded drift.

b - Only partly built, men waited too long.

c - One built and another partly built, but an explosion blew down the first one.

d - Second barricade unfinished; air bad from start.

e - Started out of barricade too soon and was found dead; 1 horse saved.

f - Started out of barricade too soon and were found dead; 13 horses saved.

g - Three additional rescue workers were killed by a fall of rock.

h - 22 men behind barricade; 27 men between doors; 40 men behind a door.

i - Men entered air lock and awaited rescue.

j - Dead some time when found.

k - One of the 7 who were rescued died later.

Original from THE OHIO STATE UNIVERSITY

In 1923, the United States Bureau of Mines published Miners' Circular 25, bearing practically the same title as does this Information Circular, which is available to individuals as well as to mining companies for distribution to their employees. In it the gases found in mines are briefly described, the changes in a mine atmosphere which are likely to take place during a fire or explosion are explained, suggestions are made as to what to do at the time of fire or explosion, a tabulation is given of known barricading incidents largely in mines of the United States from 1909 to 1923, and the types of barricades constructed in eleven coal mines and in three metal mines whereby 324 lives were saved are described in some cases with sketches and photographs. Other means of self-preservation such as refuge chambers and the use of compressed air, are described; manipulation of doors and other types of draft control are also treated.

Due at least in part to data given in Miners' Circular 25 and to the teachings of the field men of the Bureau of Mines as well as (in one case at least) through the motion picture films of the Bureau of Mines, the practice of barricading became fairly widely known and understood. The number of lives saved by this means since Miners' Circular 25 appeared in 1923 has amounted to at least 300. To date as many as 727 lives are known to have been saved by barricading in mines of the United States since 1909, two additional cases saving 103 lives having been added to the period 1909 to 1923 covered by Miners' Circular 25. The accompanying table gives some of the essential details.

The barricades in general are merely some kind of hastily constructed but practically air-tight "stopping" or temporary wall or partition placed across one or more underground openings in such manner that there is little or no ingress or egress of air, the effect being essentially the same as the closing of the door of a cellar which has but one opening. Those who go behind the barricade are then dependent for breath upon the air within the enclosed region, and one of the mistakes which has been made in the past in barricading is not to enclose within the barricade a space large enough to hold a sufficient volume of air. Generally but little time is available for the construction of a barricade; however, heavy bulkheads have been made of timber laid "skin to skin," with the spaces between timbers filled with mud, clothing, etc.; boards have been used successfully by chinking the spaces between the boards and between the ends of the boards and the mine walls with cloth, mud, etc., the cloth frequently being the clothing of the entrapped men; partitions or barricades have been constructed largely of canvas or brattice cloth; and successful barricades have been made by erecting two walls of coal or rock about 2 or 3 feet apart and filling the space between the walls with finely divided dry, or preferably wet, coal or dirt.

While not in any way relaxing efforts to prevent fires and explosions, some progressive mining companies have adopted the practice of providing beforehand suitable materials or equipment or places for barricading or to give the effect of barricading in case of fire or explosion or similar accident. One of the large copper mines in Arizona has established in the various levels of the mine over 50 "safety chambers" with air-tight doors behind which men who may be in danger from poisonous gases from fires or from blasting in sulphide ores may enclose themselves. These safety chambers are provided with electric lights, drinking water, compressed-air pipes and valves, and other accessories which might be of aid to men forced to remain in these safety chambers for considerable periods of time. While these safety chambers have not been needed in this particular mine in so far as mine fires are concerned, they have been used to very good advantage by underground workers to escape poisonous fumes from blasting.

There are numerous modifications of the safety or refuge chamber idea in both coal and metal mines. One coal-mining company in Pennsylvania has gone to considerable expense to provide concrete-lined refuge rooms of a permanent character in parts of the mine, these rooms being connected to the surface by drill holes through which air, water, food, etc., may be sent to persons who may be forced to use them; and the electric lights, water, heating facilities, telephone, etc., are connected to surface sources of supply, and hence are not likely to be put out of commission in case of underground fire or explosion. Some of these refuge chambers are well outfitted as underground emergency hospitals, and the first-aid and other emergency hospital equipment is available for use if any of the "refugees" happen to be injured.

Where two mines adjoin and are required by law or for some other reason to maintain access to or through each other, a rescue chamber can usually be constructed at little expense. Such a place has been prepared and is maintained in a crosscut which connects the 5700-foot level (incline depth) of two deep metal mines in California. This chamber was made by enclosing about 75 feet of crosscut between two concrete bulkheads with close-fitting iron doors. A 2-inch air line, 1-inch water line, and wire for mine telephone enter the chamber from both mines, the two systems being separate and independent of one another. The chamber also contains four fire extinguishers and 200 feet of hose.

In a large-capacity, modernly equipped, and up-to-date Canadian metal mine, refuge stations, averaging about 6,500 cubic feet in size and of a number to accommodate comfortably all men in that area, have been established on producing levels and in fresh airways. They are in dead ends or in specially driven headings in new ground. Tight-fitting doors have been attached. All stations are equipped with electric lights, telephone, and compressed-air and water pipes, besides other equipment. So that the men may know where these stations are, they eat lunch in them; also, meetings are held in them.

Survivors of mine explosions or fires are likely to become panic stricken during the period more or less immediately after the fire or explosion; frequently they make a dash to try to reach the surface, through the accustomed path, and in many cases have been killed while battling their way through heated air, smoke, and gases. Observation by Bureau of Mines safety men over many years presents convincing proof that persons who survive in mines after explosions or fires are far more likely to be saved ultimately if instead of trying to force their way through smoke, gases, etc., they retreat to some "blind end" and try to protect themselves from the harmful gases by barricading, taking precautions if possible to choose a place with large volume of air and not to choose a place in which the air has already been vitiated.

During 1930, a barricade was exhibited by the United States Bureau of Mines at several conventions or meetings of those interested in safety in mining. Mine timbers, board, coal, and rock were used. A large map showed the section of a mine affected by an explosion and where the air was short-circuited and the barricade built. Suitable signs were at hand to try to make the exhibit clear to understand, and it attracted considerable attention from coal operators, miners, and the public, and caused numerous arguments of various kinds, all of which ultimately were of educational value.

To instruct men how to protect themselves at time of disaster underground, several mining companies and mining organizations at first-aid and mine-rescue contests have in recent years staged problems in barricading. One progressive coal-mining company staged the following: A section of a mine is laid off on the surface by means of posts and wire rope. A number of miners, a shot firer, and an assistant foreman are supposed to be at work in the various rooms and entries. Fire is discovered and an alarm is given. The men assemble and they hang a canvas across the main entry. After some exploration in which they find escape cut off they decide to build a barricade and proceed to collect suitable materials; in this case, canvas and other materials are so placed that they can be assembled. When the barricade is finished the men await rescue which takes place in about 30 minutes from the start of the problem, although 12 hours are supposed to elapse.

The year 1932 up to December 1 promised to have the lowest coal-mine fatality rate of any period in the history of American mining during the present century, even though early in the year three explosions in Virginia had killed 54 men. However, explosions were numerous in December - one in Kentucky killed 23, one in Colorado killed 1, one in New Mexico killed 14, one in Washington killed 2, and a very bad one in Illinois killed 54. The total fatalities in explosions in the coal mines of the United States in 1932 are 167. While every one of these explosions was due to some carelessness or negligence, it is apparent that fires and explosions are likely to occur, and that our underground workers should be at all times familiar with the best methods of protecting themselves if they continue to live after a fire or explosion occurs while they are underground.

Original from THE OHIO STATE UNIVERSITY